VISIONIAS
INSPIRING INNOVATION

WASTE MANAGEMENT

QUICK REVISION MODULE **[UPSC PRELIMS 2022]** **ENVIRONMENT**

Classification of Waste:

BASED ON PROPERTIES	BASED ON ORIGIN AND TYPE	BASED ON IMPACT ON HUMAN HEALTH AND ENVIRONMENT
BIODEGRADABLE	INDUSTRIAL	HAZARDOUS
NON BIODEGRADABLE	MUNICIPAL	NON HAZARDOUS
	BIO-MEDICAL	
	AGRICULTURE	

IMPACT OF WASTE ACCUMULATION	SOIL CONTAMINATION	AQUATIC LIFE-CORAL BLEACH, ALGAL BLOOK	TERRESTRIAL LIFE-RESPIRATORY DISEASES, DECREASED PHOTOSYNTHESIS	LAND AND AIR POLLUTION

India produces:

52% Biodegradable waste

32% Non-Biodegradable waste

17% Recyclable waste

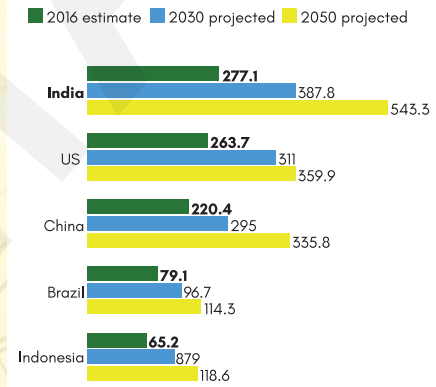
SOLID WASTE MANAGEMENT (SWM)

Most Preferred

- **At Source Reduction & Reuse:** Waste minimization and sustainable use/multi use of products (e.g. reuse of carry bags/packaging jars).
- **Recycling:** Processing non-biodegradable waste to recover commercially valuable materials (e.g. plastic, paper, metal, glass and e-waste recycling)
- **Composting:** Processing organic waste to recover compost (e.g. window composting, in-vessel composting, vermi composting)
- **Waste to Energy:** Recovering energy before final disposal of waste (e.g. RDF, biomethanation, co-processing of combustible non-biodegradable dry fraction of MSW, incineration).
- **Landfills:** Safe disposal of inert residual waste at sanitary landfills.

Least preferred

TOP 5 MUNICIPAL SOLID WASTE GENERATORS ANNUALLY (in million tonnes)



The MDeC estimates that only 75-80% of the total municipal waste gets collected and only 22-28% of this is processed and treated.

MoHUA (2020), though India generates 147, 613 metric tonnes (MT) of solid waste per day, the per capita waste per day, the per capita waste generation is just 450g.

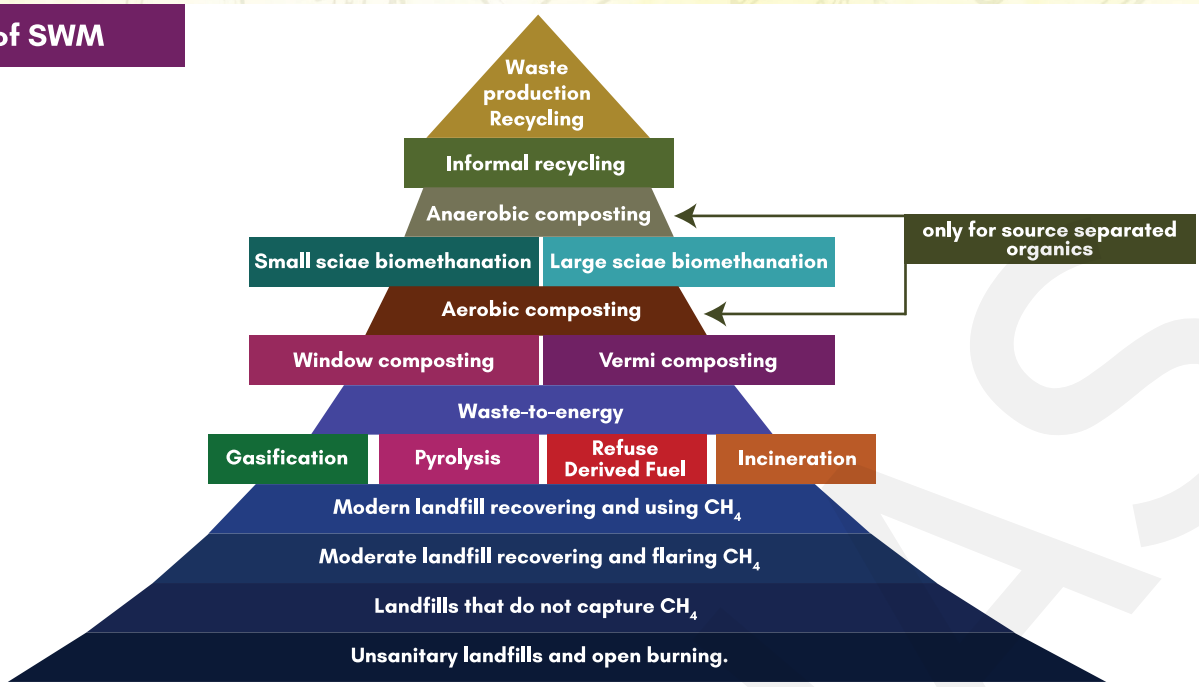
Challenges to effective SWM.

1. SEGREGATION Absence of planned segregation at source
2. Disposal Ever expanding landfill sites, methane production, leaching
3. Failure of waste to energy projects Lack of technology and resource
4. Lack of coordination among Centre and State
5. Increasing Urbanization and lack of appropriate funding

Method of disposal of Solid Waste

- **Incineration:** It is controlled high temperature oxidation (burning/thermal treatment) of primarily organic compounds that produce thermal energy, CO_2 and water.
- **Pyrolysis:**" In this process the solid is converted in to liquid state and liquid is converted in to gas.
- **Gasification:** The material to be treated is directly converted in to syngas (synthetic gas) which has hydrogen and carbon dioxide as its components.
- **Bioremediation:** Bioremediation is the use of living organisms, primarily microorganisms, to degrade environmental contaminants into less toxic forms e.g.: Pseudonymous bacterium can decompose synthetic pesticide. Bioremediation techniques are more economical than traditional methods and pollutants can be treated on site, thus reducing exposure risks for personnel.

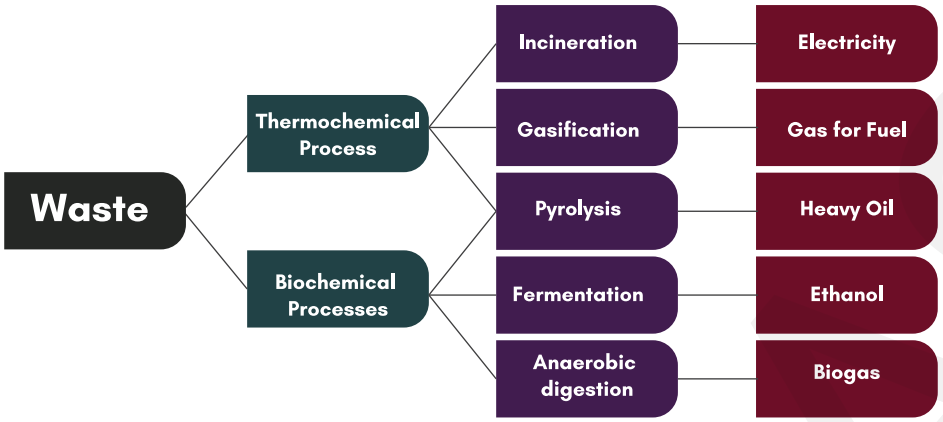
Methods of SWM



Solid waste management Rules, 2016

1. Segregation at source	■ Responsibility of waste generators to segregate waste into three streams–Biodegradables, Dry (Plastic, Paper, metal, Wood, etc.) and Domestic Hazardous waste (diapers, napkins, mosquito repellants, cleaning agents etc.) before handing it over to the collector.
2. Collection and disposal of sanitary wastes	■ Sanitary napkin producers would raise awareness for proper disposal and would provide pouch/wrapper for its disposal.
3. Collect back scheme	■ Brand owners to place a system to collect back packaging materials which are non-biodegradable.
4. User fees and spot fines	■ Municipal authorities will levy 'user fees' from bulk generators and a "Spot Fine" for littering and non-segregation.
5. Waste processing and treatment	■ Bio-degradable waste should be processed, treated and disposed of through composting or bio-methanation within the premises as far as possible and the residual waste shall be given to the waste collectors. ■ At least 5% of the total area or minimum 5 plots/sheds would be earmarked in a SEZ or industrial park for recovery and recycling facility.
6. Promoting use of compost and waste to energy	■ All industrial units located within 100 km of a solid waste based Refuse-Derived-Fuel to replace at least 5% of their fuel requirement through RDF. ■ Co-marketing of compost with chemical fertilizers by Ministry of fertilizer. Minister of Agriculture to propagate use of compost on farm land.
7. Management of waste in Hilly areas	■ Construction of landfills in hilly areas to be avoided and instead landfill sites to be chosen in a plain area within 25 km.
8. Central Monitoring committee	■ To monitor to overall implementation of rules under chairmanship of Secretary of MoEFCC.

Waste to Energy

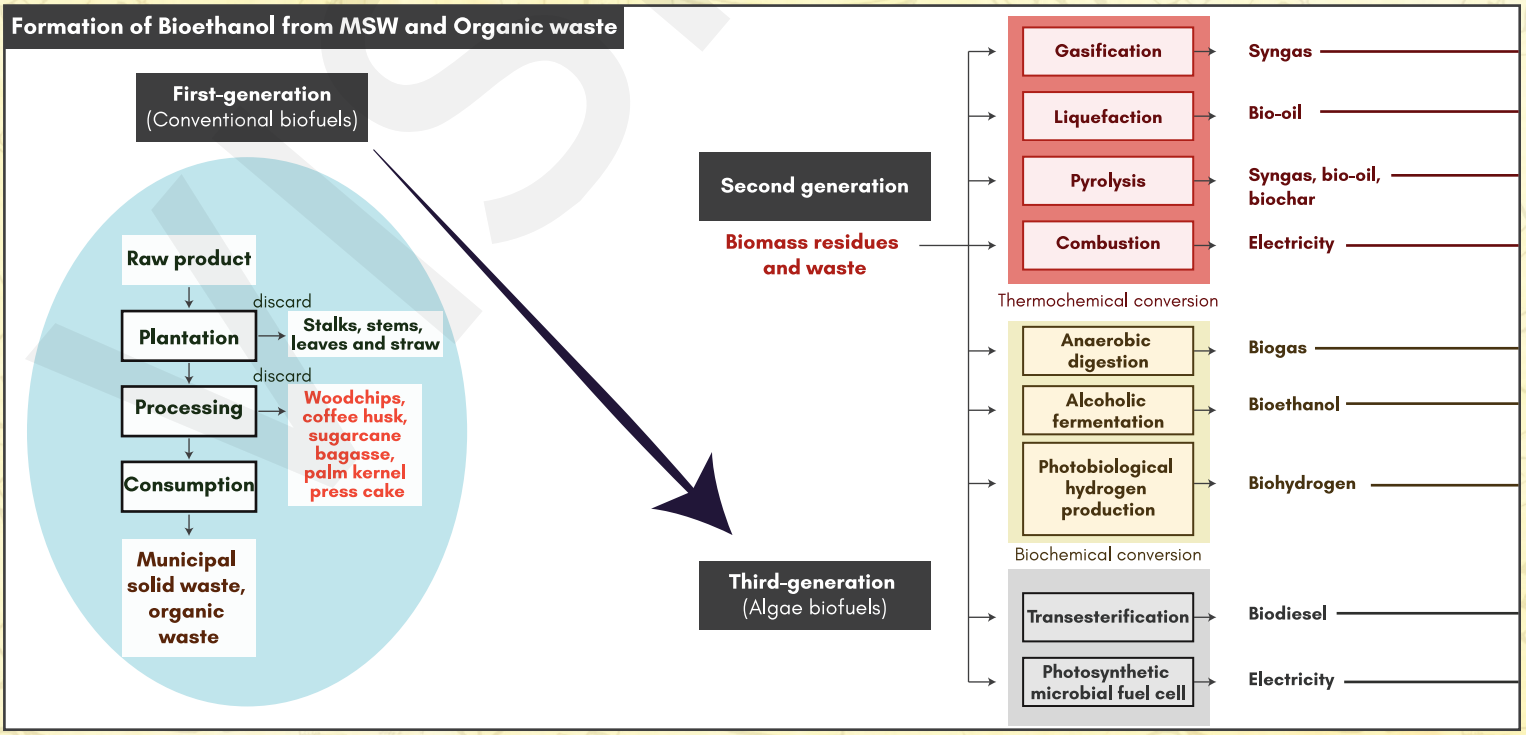


W2E Technologies – Pros and Cons

Technology	Advantages	Bottlenecks
Digestion	■ Can work on small scales ■ Monetizes the entire waste	■ High capital and operating costs ■ Long periods for biogas recovery ■ Q & M Problems in large-scale ■ Can work only for starchy, organic waste
Pyrolysis	■ High monetization owing to production of charcoal or bio-oil. ■ Ideal for treating waste plastics	■ Technology still not fully established in terms of economics.
Gasification	■ Efficient method for W2E ■ Can handle mixed wastes easily ■ Diversity of products/power production mechanisms	■ High capital costs ■ Not fully established for MSW to energy
Incinerationt	■ Simple to operate ■ Relatively lower capital and operating costs ■ Well known technology	■ Poor overall monetization of waste ■ Pollution problems

MNRE estimates that 500 MW of energy can be generated from MSW which can be further enhanced to 1075 MW by 2031 and 2780 MW by 2050.

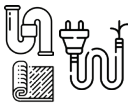
Formation of Bioethanol from MSW and Organic waste



Plastic Pollution

Which plastics are recyclable?

Summary of plastic polymer groups, their common uses, properties and recyclability. Numerical coding (from 1-7) is typically provided on plastic items and gives information of their polymer grouping below. recyclability is based on common recycling schemes but can vary between countries as well as regionally within countries; check local recycling guidelines for further clarification.

Symbol	Polymer	Common Uses	Properties	Recyclable?
1 PETE	Polyethylene terephthalate	 Plastic bottles (waster, soft drinks, cooking oil)	Clear, strong and lightweight	Yes; widely recycled
2 HDPE	High-density polyethylene	 Milk containers, cleaning agents, shampoo bottles, bleach bottles	Stiff and hardwearing; hard to be breakdown in sunlight	Yes; widely recycled
3 PVC	Polyvinyl chloride	 Plastic piping, vinyl flooring, cabling insulation, roof sheeting	Can be rigid or soft via plasticizers; used in construction, healthcare, electronics	Often not recyclable due to chemical properties; check local recycling
4 LDPE	Low-density polyethylene	 Plastic bags, food wrapping (e.g. bread, fruit, vegetables)	Lightweight, low-cost, versatile; fails under mechanical and thermal stress	No; failure under stress makes it hard to recycle
5 PP	Polypropylene	 Bottle lids, food tubs, furniture, houseware, medical, rope, automobile parts	Tough and resistant; effective barrier against water and chemicals	Often not recyclable; available in some locations; check local recycling
6 PS	Polystyrene	 Food takeway containers, plastic cutlery, egg tray	Lightweight; structurally weak; easily dispersed	No; rarely recycled but check local recycling
7 OTHER	Other Plastics (e.g. acrylic, polycarbonate, polyactic fibres)	 Water cooler bottles, baby cups, fiberglass	Diverse in nature with various properties	No; diversity of materials risks contamination of recycling

Plastic Waste Management Rules, 2016

- Increased minimum thickness of plastic carry bags from 40 to 50 microns.
- Rural areas have been brought in ambit of these Rules along with municipalities.
- Extended Producer Responsibility: The producers and brand owners have been made responsible for collecting waste generated from their products. They have to approach local bodies for formulation of plan/system for collecting back the plastic waste generated by them.
- Promote use of plastic waste for road construction as per Indian Road Congress guidelines or energy recovery, or waste to oil etc.
- Phasing out of Multi-layered Plastic (MLP) that are "non recyclable or non-energy recoverable or have no alternate use". (2018 amendments).
- Central Pollution Control Board (CPCB) has been mandated to formulate the guidelines for thermoset plastic (plastic difficult to recycle).
- A Central Registration System for the registration of the producer/importer/owner.
- Plastic carry bag will be available only with shopkeepers/street vendors pre-registered with local bodies on payment of certain registration fee. The fees thus collected would be used in management of waste.

Single use plastic (Draft Rules 2021 to amend PWM Rules 2016)

Single-use plastic defined as disposable plastics (use-and-throw items) that are commonly used for packaging and include items intended to be used only once before they are thrown away or recycled such as carry bags, food packaging, bottles, straws, containers, cups and cutlery.

Certain single use plastic items would be phased out in three stages by 2022. An expert committee has chosen these items on the basis of their utility and adverse impact on environment.

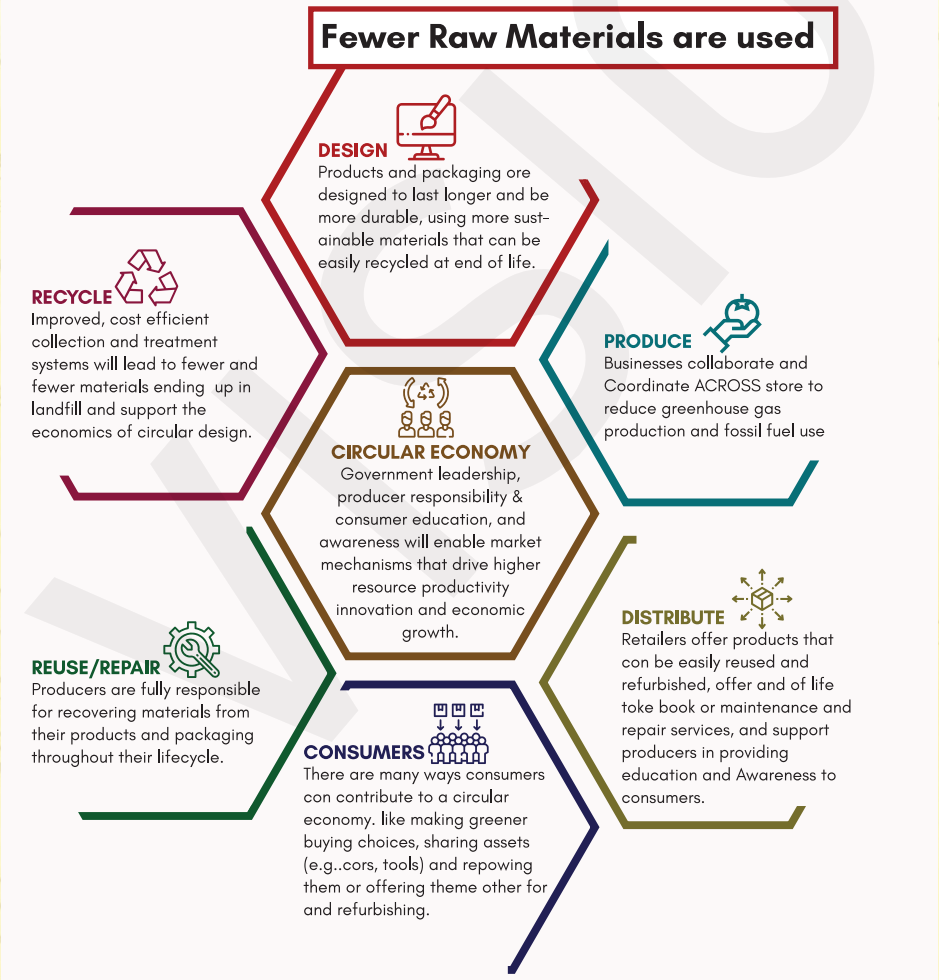
In the three-stage ban, the first category of single-use plastic items proposed to be phased out are plastic sticks used in balloons, flags, candy, ice-cream and ear buds and thermocol that is used in decorations.

The second category ban would include items such as plates, cups, wrapping films, cigarette packets etc. that are less than 100 microns in thickness.

A third category of prohibition is for non-woven bags below 240 microns or 60 GSM in thickness.

The thickness of carry bags made out of virgin or recycled plastic would be increased from 50 microns to 120 microns.

OVERVIEW OF A CIRCULAR ECONOMY



India produces around 26,000 tonnes of plastic waste per day. Single use plastic contribute 36% of 400 mt plastic produced annually.

- Single use plastic has a higher carbon footprint and is more water intensive to produce.
- Their collection is difficult and requires more capital.
- India intends to phase out single use plastic by 2022.

E-Waste

Typical pathways for the release of pollutants from e-waste are:

Heavy metals

- Dust generated during mechnical treatment, for example, the dismantling and crushing of WEEE.
- Flue gas released dunng thermal treatment. for example, the release of metals from compounds during the incineration of plastic.
- Vaporization wherein metals are released from compounds in an acid bath.

Dioxins and Furans

- Dioxins and furans are emitted dunng the thermal treatment of WEEE. for example during–
  1. The combustion of cable insulation containing PVC in order to recycle copper wring.
  2. The incineration of epoxy resin containing flame retardant from circuit boards in order to recycle the metal they contain.

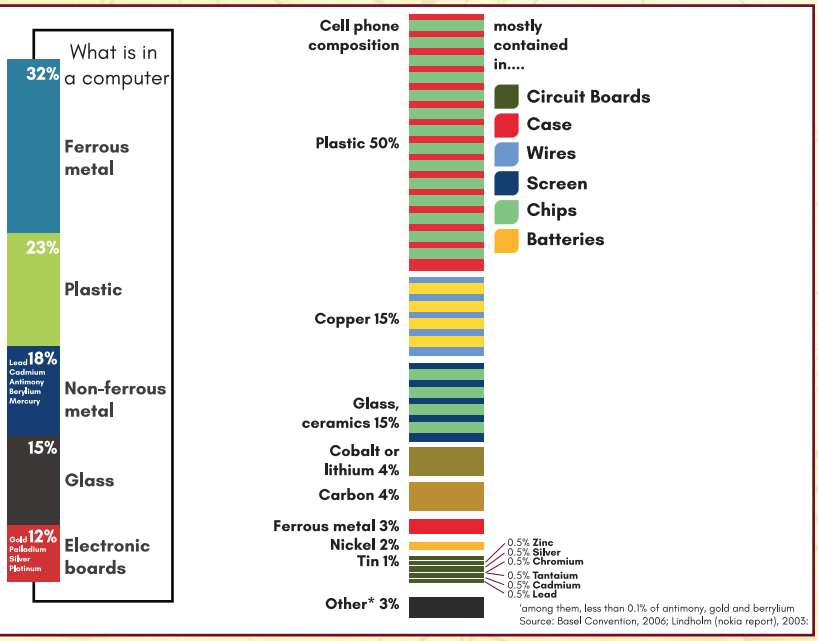
Acids

- Released in the form of vapour when metals are released from compounds May also get distnbuted throughout the surrounding area in the following ways.
- Factory air and dust being blown into the vicinity.
- Leaching through waste water and seepage.
- Release of flue gas into the atmosphere as a result of open incineration of furnace combustion.

Constituents of E-Waste

E-Waste Source	E-Waste Component	Environmental Hazard	Effects on Human
CRTs (used in TVs. Monitors. ATM, Video Camera, etc.)	Lead, barium & other heavy metals	These metals leaching into the ground water and release of toxic phosphor.	Anenua. Renal Toxicity. Insomnia
Batteries, Housing & Medical Equipment	Mercury	Air emissions as well as discharge into rivers of glass dust	Renal Toxicity. Muscle tumors. Menial retardation. Cerebral palsy
Plastics from printers keyboards, monitors etc.	Plasticizer bisephenol A(or BPA), as well DEHP and DBP, plastic compounds known as phthalates.	Chlorinated plastics release harmful chemicals into the surrounding soil, which seep into ground water or other surrounding water sources which cause serious harm to the species that drink this water.	Risk developing heart problems, obesity, reproductive disease
PVC & polymer. Paints, Printing inks. Electrical transformers & capacitors.	Polychlorinated Biphenyls (PCBs)	Include extreme pollution from production, toxic chemical exposure during use, hazards from Fires.	Suppression of immune system; Damage to the liver, nervous and reproduce systems.

50 million tons of e-waste is generated every year and by 2050 it will get doubled (UN report). India is the third largest producer of e-waste after China and USA (Global monitor report, 2020).



Hazards from e-waste substances:

Metal	Danger
Lead	A neurotoxin that affects the kidneys and the reproductive system, high quantities can be fatal. It affects mental development in children. Mechanical breaking of CRTs (cathode ray tubes) and removing solder form microchips release lead as powder and fumes.
Plastic	Found in circuit boards, cabinets and cables, they contain carcinogens BFRs or Brominated flame retardants give out carcinogenic Brominated dioxins and furans Dioxins can harm reproductive and immune systems. Burning PMC, a component of plastics, also produces dioxins BFR can leach into landfills Even the dust on computer cabinets contains BFR.
Chromium	Used to protect metal housings and plates in a computer from corrosion, inhaling Hexavalent chromium or chromium 6 can damage liver and kidney and cause bronchial maladies including asthmatic bronchitis and lung cancer.
Mercury	Affect the central nervous system, kidneys and immune system. It impairs foetus growth and harms infants through mother's milk. It is released while breaking and burning of circuit boards and switches mercury in water bodies can form methylated mercury through microbial activity. Methylated mercury is toxic and can enter the human food chain through aquatic.
Beryllium	Found in switch boards and printed circuit boards It is carcinogenic and causes lung diseases.
Cadmium	A carcinogen Long-term exposure causes Itai-Iai disease, which causes severe pain in the joints and spine It affects the kidneys and softens bones Cadmium s released into the environment as powder while crushing and milling of plastics, CRTs and circuit boards Cadnium may be released with dust, entering surface water and groundwater.
Acid	Sulphuric and hydrochloric acids are used to separate metals from circuit board's furnes contain chlorine and sulphur dioxide, which cause respiratory problems. They are corrosive to the eye and skin.

E-Waste Management Rules, 2016

E-Waste management in India

- The government passed the **first law on e-waste management in 2011, based on Extended Producer Responsibility.** However, it did not set collection targets.
- Thereafter, **the E-Waste {Management} Rules, 2016 were enacted in supersession of the 2011 Rules.**
  - A manufacturer, dealer, refurbisher and Producer Responsibility Organization {PRO) were also brought under the ambit of these Rules.
  - PRO Is a professional organization authorized or financed collectively or individually by producers, which can take the responsibility for collection and channelization of e-waste generated from their products to ensure environmentally sound management.
- The **E-Waste Management Rules, 2016 have been amended by the Centre in 2018.**
- **E -Waste (Management) Amendment Rules, 2018** objective is to channelize the e-waste generated in the country towards authorized dismantlers and recyclers in order to further formalize the e-waste recycling sector.
- **India's first E-waste clinic** is going to be set up in **Bhopal** that would enable segregation, processing and disposal of waste from both household and commercial units.
- **International Best practice:** In October 2019, the EU adopted **new Right to Repair standards,** which means that from 2021 firms will have to make appliances longer-lasting, and will have to supply spare parts for machines for up to 10 years.

Producer Responsibility Organisation: It Is an organisation that helps producers meet their EPR targets through various recyclers and dismantlers.

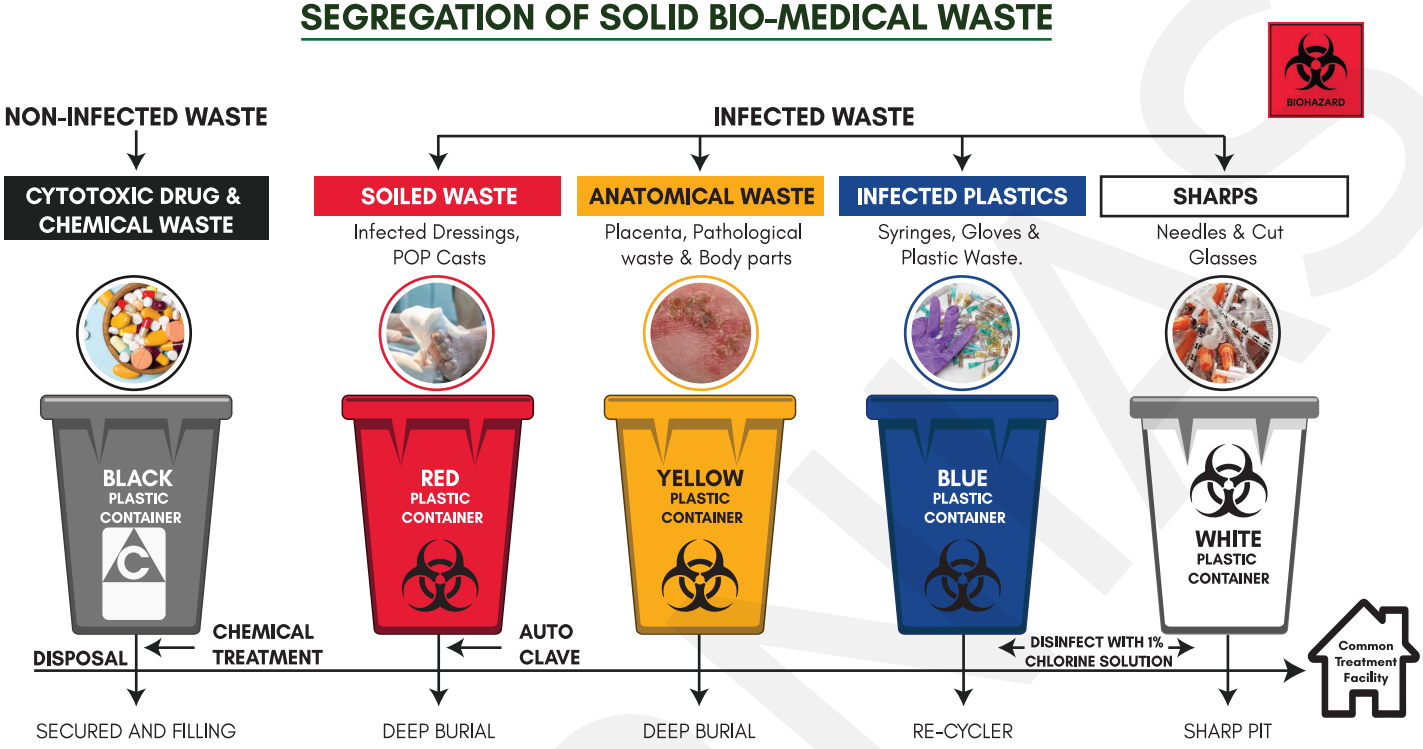
Extended Producer Responsibility (EPR): It is a strategy designed to promote the **integration of environmental costs associated with goods** throughout their life cycles into the market price of the products. Three basic objectives of EPR:

- Manufacturers shall be incentivised to improve the environmental design of their products and the environmental performance of supplying those products.
- Products should achieve a high utilisation rate.
- Materials should be preserved through effective and environmentally-sound collection, treatment.

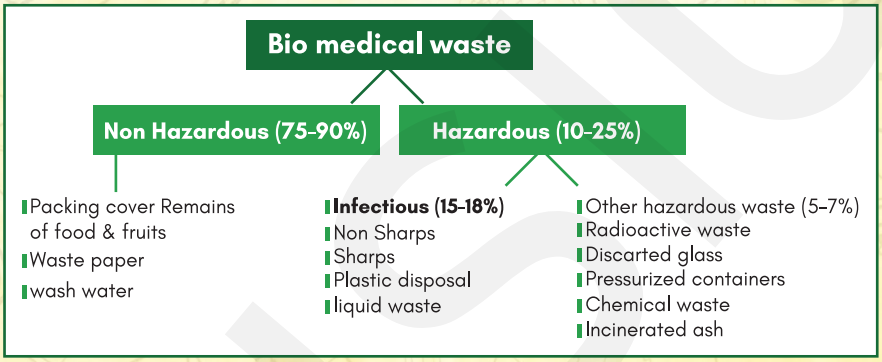
Bio-Medical Waste

As per CPCB, India generates about 101 MT per day of COVID 19 related Biomedical waste in addition to the regular bio-medical waste generation of about 609 MT per day.

SEGREGATION OF SOLID BIO-MEDICAL WASTE



Note: USE ANY COLORED BIN OTHER THAN BLACK, RED, YELLOW, BLUE & WHITE FOR DISPOSAL OF GENERAL WASTE



Key features of Bio-medical Waste Management Rules 2016(amended in 2018)

- Widened jurisdiction- The ambit of the rules was widened to include vaccination camps, blood donation camps, surgical camps etc.
- **Pre-treatment of waste:** Waste generated in laboratories, microbiological waste, blood samples and blood bags to be pre-treated through disinfection or sterilization on-site in the manner as prescribed by WHO.
- **Phasing out** of use of chlorinated plastic bags, gloves and blood bags by **March 2019.**
- **Better segregation:** Bio-medical waste has been classified into **4 categories:** Untreated human anatomical waste, Animal anatomical waste, Soiled waste and Biotechnology waste.
- **Storage of waste:** Provision within the premises for a safe, ventilated and secured location for storage of segregated biomedical waste.
- **Regular Training and Immunisation** of all health care workers.
- **Ensure proper Transportation and handling of waste** without any adverse effect to the human health and the environment.
- **Record maintenance and monitoring** of the activities related to bio-medical waste management.
- **Establish GPS and Bar-coding facility at** Common biomedical waste treatment facility.

INTERNATIONAL INITIATIVES FOR WASTE MANAGEMENT

1 Basel Convention on Transboundary movement of Hazardous wastes

- Adopted in 1989 and entered into force in 1992 to protect human health and the environment against the adverse effects of hazardous wastes.
- Defines **"hazardous wastes"** based on their origin and/or composition and their characteristics. Mentions two **"other wastes"** – household waste and incinerator ash.
- The **guiding principles of the Convention** are that transboundary movements of hazardous wastes should be: reduced to a minimum; minimized at the source; managed in an environmentally sound manner; and treated and disposed of as close as possible to their source of generation.
- Includes the concept of prior informed consent.

2 Rotterdam Convention on Prior Informed Consent (PIC)

- Adopted in 1998 and entered into force in 2004.
- Jointly administered by **FAO and UNEP.**
- **Legally binding obligations** for the implementation of the **Prior Informed Consent (PIC)** procedure.
- **Its aim is to** promote shared responsibility and cooperative efforts among parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm.
- The Convention **covers pesticides and industrial chemicals** that have been banned or severely restricted for health or environmental reasons by Parties and which have been notified by Parties for inclusion in **Annex III for the purpose of PIC procedure.**

3 Stockholm Convention on Persistent Organic Pollutants

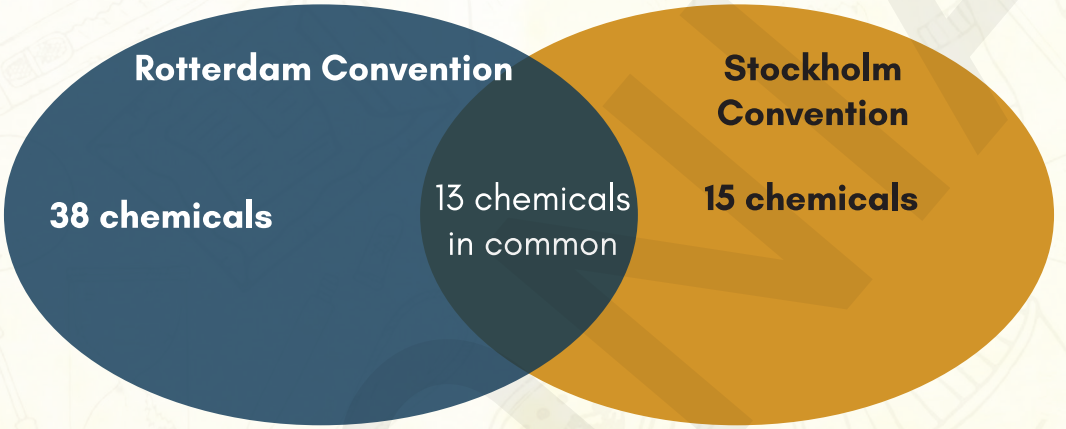
- Adopted in May 2001 and entered into force in 2004.
- It calls for international action on three categories of POPs: pesticides, industrial chemicals, and unintentionally produced POPs.
- Elimination (POPs in annex A); Restriction (POPs in annex B) & Reduction or elimination (unintentionally produced POPs in annex C).
- Parties to prevent the development of new POPs and promote best available techniques (BAT) and best environmental practices (BEP) for replacing existing POPs.
- It initially addressed 12 substances (known as "the dirty dozen") but now 30 chemicals are listed under it.
- GEF addresses its finance mechanism and UNIDO helps developing countries in implementation of Stockholm convention.

Major decisions at 2019 joint Conferences of the Parties to the Basel (COP-14), Rotterdam (COP-09) and Stockholm (COP-09) convention.

- **Under Basel Convention:** Adoption of an amendment to include unsorted, mixed and contaminated **plastic waste under PIC (Prior Informed Consent) procedure** and improve the regulation of its transboundary movement.
  - **Establishment of a Partnership on Plastic Wastes.** The partnership will embark on its activities after 2020.
  - Provisional adoption **of Technical Guidelines on Transboundary Movements of E-Waste and Used Electrical and Electronic Equipment:** It provides a list of criteria for member countries in objectively **distinguishing between waste and non-waste** under the Basel Convention when importing for reuse.
- **Under the Rotterdam Convention: Establishment of a compliance mechanism** to assist Parties to identify and address gaps in complying with the Convention and enable them to take informed risk while importing chemicals.
  - Two chemicals, the **pesticide** phorate and the industrial chemical **hexabromocyclododecane (HBCD)** were added to Annex III, making them subject to the PIC Procedure.
- **Under Stockholm Convention: Listing for elimination of dicofol and perfluorooctanoic acid (PFOA),** its salts, and PFOA-related compounds under **Annex A of the Convention,** which obliges Parties to eliminate these chemicals from use.
  - **Dicofol** is used as a **miticide on a variety of field crops,** fruits, vegetables, ornamentals and tea and coffee and is known to cause skin irritation in humans and is toxic to fish, birds and algae.
  - **PFOA** is a widely-used **industrial chemical** used in the production of non-stick cookware and food processing equipment, as well as a surfactant in textiles, carpets, paper, paints and firefighting foams. It can cause kidney cancer, testicular cancer, thyroid disease and hypertension in pregnancy.

SDGs: Goals, targets and indicators of relevance to the Basel, Rotterdam and Stockholm conventions

- 2 ZERO HUNGER
- 3 GOOD HEALTH AND WELL-BEING
- 6 CLEAN WATER AND SANITATION
- 11 SUSTAINABLE CITIES AND COMMUNITIES
- 12 RESPONSIBLE CONSUMPTION AND PRODUCTION



whenever they are banned or become wastes

Basel Convention

Basel Ban Amendment

- The Ban Amendment prohibits all export of hazardous wastes, including electronic wastes and obsolete ships from 29 wealthiest countries of the Organization of Economic Cooperation and Development (OECD) to non-OECD countries.
- Countries like the US, Canada, Japan, Australia, New Zealand, South Korea, Russia, India, Brazil, and Mexico are yet to ratify the ban.